PAAVAI ENGINEERING COLLEGE, NAMAKKAL – 637 018

(AUTONOMOUS)

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

REGULATONS 2016

(CHOICE BASED CREDIT SYSTEM)

CURRICULUM

SEMESTER V

S.No	Category	Course Code	Course Title	L	T	P	C
Theory							
1	PC	EE16501	Electrical Machines II	3	0	0	3
2	PC	EE16502	Control Systems	3	2	0	4
3	PC	EE16503	Power Electronics	3	0	0	3
4	ES	EE16504	Digital Signal Processing	3	2	0	4
5	PC	EE16505	Transmission and Distribution	3	0	0	3
6	PE	EE1615*	Programme Elective I	3	0	0	3
Practical							
7	PC	EE16506	Electrical Machines II Laboratory	0	0	4	2
8	PC	EE16507	Control Systems Laboratory	0	0	4	2
9	PC	EE16508	Power Electronics Laboratory	0	0	4	2
10	EE	EN16501	Career Development Laboratory I	0	0	2	1
			TOTAL	18	4	14	27

SEMESTER VI

S.No	Category	Course Code	Course Title	L	T	P	C
Theory							
1	PC	EE16601	Design of Electrical Apparatus	3	2	0	4
2	PC	EE16602	Solid State Drives	3	0	0	3
3	PC	EE16603	Power System Analysis	3	0	0	3
4	PC	EE16604	Microprocessors and Microcontrollers	3	0	0	3
5	PC	EE16605	Programmable Logic Controllers	3	0	0	3
6	OE	EE1690*	Open Elective I	3	0	0	3
Practical							
7	PC	EE16606	Electrical Drives Laboratory	0	0	4	2
8	PC	EE16607	Microprocessors and Microcontrollers Laboratory	0	0	4	2
9	EE	EN16601	Career Development Laboratory II	0	0	2	1
			TOTAL	18	2	10	24

LIST OF ELECTIVES

S.No	Category	Course Code	Course Title	L	T	P	C
PROGRAMME ELECTIVE I (PE)							
1	PE	EE16151	Bio Medical Engineering	3	0	0	3
2	PE	EE16152	Electrical Safety	3	0	0	3
3	PE	EE16153	Digital Control Engineering	3	0	0	3
4	PE	EE16154	Nano Science	3	0	0	3
5	PE	EE16155	Network Analysis and Synthesis	3	0	0	3
OPEN ELECTIVE I (OE)							
1	OE	EE16901	Micro Electro Mechanical System	3	0	0	3
2	OE	EE16902	Industrial Robotics	3	0	0	3
3	OE	EE16903	Soft Computing Techniques	3	0	0	3
4	OE	EE16904	Wind and Solar Energy Systems	3	0	0	3

SEMESTER V

EE16501 ELECTRICAL MACHINES II 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- impart knowledge on operation of AC generators and methods for determining regulation of AC generator
- understand the operation of AC motors and starting methods
- learn the concepts of operating principle and predetermination of parameters of induction motor.
- study the starters and speed control methods of various motors.
- understand the operation of single phase induction motors and special machines.

UNIT I SYNCHRONOUS GENERATOR 9

Constructional details - Types of rotors - emf equation - Synchronous reactance - Armature reaction - Voltage regulation - E.M.F, M.M.F, Z.P.F and A.S.A methods - Synchronizing and parallel operation - Synchronizing torque - Change of excitation and mechanical input - Two reaction theory - Determination of direct and quadrature axis synchronous reactance using slip test - Operating characteristics.

UNIT II SYNCHRONOUS MOTOR 8

Principle of operation - Torque equation -Operation on infinite bus bars - V and inverted V curves - Power input and power Developed equations - Starting methods - Current loci for constant power input, constant excitation and constant power developed.

UNIT III THREE PHASE INDUCTION MOTOR 12

Constructional details - Types of rotors - Principle of operation - Slip - Equivalent circuit - Slip torque characteristics - Condition for maximum torque - Losses and efficiency - Load test - No load and blocked rotor tests - Circle diagram - Separation of no load losses - Double cage rotors - Induction generator - Synchronous Induction motor.

UNIT IV STARTING AND SPEED CONTROL OF THREE PHASE INDUCTION MOTOR 7

Need for starting - Types of starters - Stator resistance and reactance, rotor resistance, autotransformer and star-Delta starters - Speed control - Change of voltage, torque, number of poles and slip - Cascaded connection - Slip Power recovery scheme.

UNIT V SINGLE PHASE INDUCTION MOTORS AND SPECIAL MACHINES 9

Constructional details of single phase induction motor - Double revolving field theory and operation - Equivalent circuit - No load and blocked rotor test - Performance analysis - Starting methods of single - phase induction motors - Special machines - Shaded pole induction motor, reluctance motor, repulsion motor, hysteresis motor, stepper motor and AC series motor.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- determine the regulation of synchronous generator.
- analyze the performance of synchronous motor.
- describe the performance of three phase induction motor.
- explain the concept of starting and speed control of induction motors.
- enumerate the operation of single phase induction motor and special machines.

TEXT BOOKS

1. B.L.Theraja, A.K.Theraja, "Electrical Technology", Volume 2, S.Chand Publishers, 2015.
2. D.P. Kothari and I.J. Nagrath, "Electric Machines", Tata McGraw Hill Publishing Company Ltd, 2010.

REFERENCES

1. A.E. Fitzgerald, Charles Kingsley, Stephen.D.Umans, "Electric Machinery", Tata McGraw Hill publishing Company Ltd, 2008.
2. J.B. Gupta, "Theory and Performance of Electrical Machines", S.K.Kataria and Sons, 2015, International Publishers, 2012.
3. K. Murugesh Kumar, "Electric Machines", Vikas publishing house Pvt Ltd, 2002.\
4. Mehta. V.K and Rohit Mehta, "Principle of Electrical Machines", S.Chand Publishers, 2009.
5. Rajput. R.K, "A Text Book of Electrical Machines", Firewall Media, 2008.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

	Programme Outcomes PO's												PSO's	
CO's	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	3	3	-	3	-	-	-	-	-	3	-	3	3
CO2	3	3	-	-	3	-	-	-	-	-	3	-	3	3
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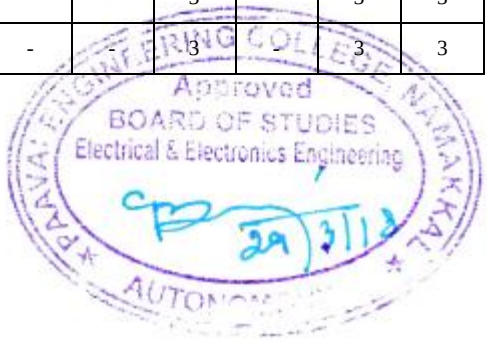
CO4	3	3	-	-	-	-	-	-	-	-	3	-	3	3
CO5	3	3	3	3	3	-	-	-	-	-	3	-	3	3



EE16502 CONTROL SYSTEMS 3 2 0 4

COURSE OBJECTIVES

To enable the students to

- understand the methods of representation of systems and to obtain system transfer function models.
- provide knowledge on time response of systems and steady state error analysis.
- acquaint basic knowledge in obtaining the open loop and closed–loop frequency responses of systems.
- impart the concept of stability of control system and methods of stability analysis.
- study the design of compensators for a control system.

UNIT I SYSTEMS AND THEIR REPRESENTATION 9+6

Basic elements in control systems - Open and closed loop systems - Electrical analogy of mechanical and thermal systems - Transfer function - Synchros - AC and DC servomotors - Block diagram reduction techniques - Signal flow graphs.

UNIT II TIME RESPONSE 9+6

Time response - Time domain specifications - Types of test input - I and II order system response - Error coefficients - Generalized error series - Steady state error - P, PI, PID modes of feedbackcontrol.

UNIT III FREQUENCY RESPONSE 9+6

Frequency response - Bode plot - Polar plot - Constant M and N circles - Nichol‟s chart - Determination of closed loop response from open loop response - Correlation between frequency domain and time domain specifications.

UNIT IV STABILITY OF CONTROL SYSTEM 9+6

Characteristics equation - Location of roots in S plane for stability -Routh Hurwitz criterion - Root locus construction - Effect of pole, zero addition - Gain margin and phase margin -Nyquist stability criterion.

UNIT V COMPENSATOR DESIGN 9+6

Performance criteria - Lag, lead and lag-lead networks - Compensator design using bode plots and root locus. Introduction to MATLAB Simulink.

TOTAL PERIODS 75

COURSE OUTCOMES

At the end of this course, students will be able to

- model a control system using differential equations and transfer functions.
- analyze the transient response of control systems in using time domain.
- evaluate and analyze control systems using frequency domain methods.
- check the stability of systems and the effect of pole zero addition.

- design compensators for control systems.

TEXT BOOKS

1. I.J. Nagrath& M. Gopal, "Control Systems Engineering", New Age International Publishers, 2017.
2. A.Nagoorkani "Control Systems", RBA Publications,2012.

REFERENCES

1. B.C. Kuo, "Automatic Control Systems", Prentice Hall of India Ltd., 2014.
2. M. Gopal, "Control Systems, Principles & Design", Tata McGraw Hill, 2015.
3. K. Ogata, "Modern Control Engineering", Pearson Education, 2015.
4. S.K.Bhattacharya, "Control System Engineering", Pearson, 2013.
5. Arthur, G.O.Mutambara, "Design and Analysis of Control; Systems", CRC Press, 2017.

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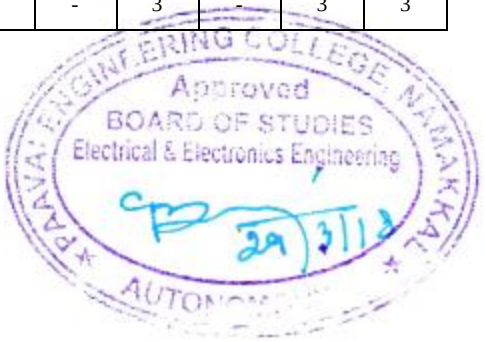
CO5	3	3	3	-	3	-	-	-	-	-	3	-	3	3



EE16503 POWER ELECTRONICS 3 0 0 3

(Common to EEE & MCT)

COURSE OBJECTIVES

To enable the students to

- impart knowledge on different types of power semi-conductor devices and their switching characteristics
- understand the operation of converter and their firing circuits and different commutation techniques of power converters.
- know the operation of various chopper conversion techniques and basics of resonance converter.
- study the mode of inverters and different modulation techniques.
- learn the types of AC voltage controllers and basics of matrix converters.

UNIT I POWER SEMICONDUCTOR DEVICES 9

Study of switching devices, Diode, SCR, TRIAC, GTO, BJT, MOSFET, IGBT- Static and Dynamic Characteristics - Commutation: Natural Commutation, Forced commutation, snubber circuit.

UNIT II PHASE - CONTROLLED CONVERTERS 9

2- pulse, 3-pulse and 6-pulseconverters - performance parameters - Effect of source inductance – gate circuit schemes for phase control - Dual converters.

UNIT III CHOPPER 9

Step-down and step-up chopper - control strategy -Forced commutated chopper: Voltage commutated, Current Commutated, Switched mode regulators - Buck, boost, buck-boost converter. Introduction to Resonant Converters.

UNIT IV INVERTERS 9

Single phase and three phase voltage source inverters (both120^0mode and180^0mode) - PWM techniques: Sinusoidal PWM, modified sinusoidal PWM - multi PWM - Introduction to space vector modulation - Current source inverter - Introduction to multilevel inverter.

UNIT V AC TO AC CONVERTORS 9

Single phase and three phase AC voltage controllers - control strategy - power factor control - multistage sequence control - single phase and three phase cycloconverters - Introduction to matrix converters.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of this course, students will be able to

- identify and select the switching devices for different power converter applications.
- apply the different converter based on the application.

- design a suitable DC power supply for given load specification from DC supply.
- describe and analyze the single and three phase inverter.
- explain an AC voltage controller electromagnetic compatibility of power converters.

TEXT BOOKS

1. M.H.Rashid, Power Electronics: Circuits, Devices Applications, Pearson, 2016.
2. M.D. Singh and Khanchandani K.B., Power Electronics, Tata Mc.Graw Hill., 2016

REFERENCES

1. L.Umanand, Power Electronics Essentials and Applications, Wiley India Pvt Ltd, Reprint, 2010.
2. G.K. Dubey, S.R. Doradla, A. Joshi and R.M.K. Sinha, Thyristorised Power Controllers, New Age,International Publishers, 2012.
3. Ned Mohan,Tore M. Undeland and William P.Robins, Power Electronics – Converters, Applications and Design Third Edition, John Wiley and Sons, 2008.
4. R.S. Ananda Murthy and V. Nattarasu, Power Electronics: A Simplified Approach, Pearson/Sanguine Technical Publishers,2009 .
5. Daniel W.Hart, Power Electronics, McGraw-Hill Publishing Company Ltd, 2011.

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CO2	3	3	3	3	-	-	-	-	-	-	-	-	3	3
CO3	3	3	3	3	-	-	-	-	-	-	-	-	3	3
CO4	3	3	3	3	-	-	-	-	-	-	-	-	3	3
CO5	3	3	3	3	-	-	-	-	-	-	-	-	3	3

EE16504 DIGITAL SIGNAL PROCESSING 3 2 0 4

COURSE OBJECTIVES

To enable the students to

- understand the classification of signals and systems & their mathematical representation.
- analyze the discrete time systems using Z transform
- perform frequency analysis of signals and computation of discrete Fourier transform
- study the concepts and design of digital IIR filter
- learn the concepts and design of digital FIR filter

UNIT I DISCRETE TIME SIGNAL AND SYSTEMS 9+6

Characteristics and classification of signals-discrete time signal-basic definitions - representation of signals, discrete time systems-linear time invariant systems-properties of LTI systems-linear constant coefficient difference equations - Fourier transform of discrete time signals, sampling techniques - Nyquist rate, aliasing effect.

UNIT II Z- TRANSFORM AND FILTER REALIZATION 9+6

Z Transform and its properties - inverse Z transform - stability - causality - linear difference equations with Constant coefficients and their solutions -digital filter realization: direct form I, II, cascade, parallel types.

UNIT III FREQUENCY ANALYSIS OF SIGNALS 9+6

Fourier transform - discrete time Fourier series - discrete Fourier transform-properties of discrete Fourier transform- computation of discrete Fourier transform - FFT algorithms- radix-2 FFT algorithm-decimation in time-decimation in frequency.

UNIT IV DIGITAL IIR FILTER 9+6

Introduction - types of filters, digital filter design-design of IIR filters-impulse invariance and bilinear transform methods- analog to digital transformation.

UNIT V DIGITAL FIR FILTER 9+6

FIR filter - design of FIR filter using windows: rectangular, triangular, hanning, hamming, Blackman windows - comparison of IIR and FIR digital filter- Effect of word length and quantization-fixed point and floating point arithmetic.

TOTAL PERIODS 45+30=75

COURSE OUTCOMES

At the end of this course, students will be able to

- perform classification of signals and systems.
- apply Z transform and analyze discrete time systems.
- compute DFT and obtain perform frequency response analysis.

- design IIR fliters.
- apply windowing technique to design FIR filters.

TEXT BOOKS

1. John G.Proakis, Dimitris G.Manolakis, "Digital Signal Processing", Prentice Hall of India, Pvt, Ltd., 3rd edition. 2007.
2. Alan V.Oppenheim, Ronald W.Schafer "Digital Signal Processing", Prentice Hall of India, Pvt Ltd., 2006.

REFERENCES

1. Simon Haykin and Barry Van Veen, "Signals and Systems", 2nd Edition, Willey Publication (Reprint), 2010.
2. SanjitK.Mitra, "Digital Signal Processing", Tata McGraw Hill, 2009.
3. P. Ramesh Babu and R.AnandaNatarajan, "Signals and Systems", SciTech Publications, 4th Edition, 2010.
4. Poorna Chandra S, Sasikala. B , "Digital Signal Processing", Vijay Nicole/TMH,2013
5. Lonnie C.Ludeman ,"Fundamentals of Digital Signal Processing",Wiley,2013

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CO1	3	3	-	-	2	-	-	-	-	-	3	-	3	3
CO2	3	3	-	-	2	-	-	-	-	-	3		3	3
CO3	3	3	-	-	2	-	-	-	-	-	3		3	3
CO4	3	3	-	-	2	-	-	-	-	-	3		3	3
CO5	3	3	-	-	2	-	-	-	-	-	3		3	3

EE16505 TRANSMISSION AND DISTRIBUTION 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- impart knowledge on the basics of transmission and distribution of power system.
- develop expression for computation of fundamental parameters of lines.
- categorize the lines into different classes and develop equivalent circuits for these classes.
- analyze the voltage distribution in insulator strings and methods to improve the same
- impart knowledge for estimation of sag and tension.

UNIT I INTRODUCTION 9

General layout of power system - Standard voltages for transmission - Advantages of high voltage transmission. Feeders, distributors and service mains. Distribution- Requirements of power distribution - Radial & Ring main systems - Overhead versus Underground System - AC and DC distribution: Calculation for concentrated and uniform loading.

UNIT II TRANSMISSION LINE PARAMETERS 9

Line parameters: Calculation of Resistance, Inductance and Capacitance of single phase and three phase overhead lines with Symmetrical and Unsymmetrical spacing for solid, stranded conductors and bundled conductors - Transposition of line conductors - Applications of self and mutual GMD - Skin and proximity effects- Interference with neighboring communication circuits.

UNIT III ANALYSIS OF TRANSMISSION LINE PERFORMANCE 9

Performance of power transmission lines- Short transmission lines - Medium transmission lines- End condenser, Nominal T and Nominal π model - Transmission efficiency and voltage regulation - Long transmission lines - ABCD constants of transmission lines, Ferranti effect.

UNIT IV INSULATORS AND CABLES 9

Insulators - Properties and types of insulators - potential distribution over a string of insulators - String efficiency - Methods of improving string efficiency. Underground Cables - Construction of LT and HT Cables - Insulation resistance, Capacitance and dielectric stress of a single core cable - Grading of cables-Capacitance of 3-corecables.

UNIT V OVERHEAD TRANSMISSION LINES AND SAG 9

Overhead Transmission Lines- Types of supporting structures and line conductors used. Sag calculation- Effect of wind and ice loading - Corona - Substation layout -Overhead transmission system in India.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- compute transmission line parameters such as resistance, inductance and capacitance of overhead transmission lines and underground cables.
- compute voltage drop and power loss in DC and AC radial, ring and interconnected distribution networks.
- categorize the different types of insulators and cables.
- evaluate the performance of overhead transmission lines based on their models
- design insulator strings for high voltage overhead transmission lines.

TEXT BOOKS

1. Soni Gupta &Bhatnaagar , "A Course in Electrical Power", DhanpatRai& Sons,2008.
2. C. L. Wadhwa, "Electrical Power Systems", New Age International,2016.
3. V.K.Mehta, Rohit Mehta, "Principles of Power Systems", S. Chand &Co., 2012.

REFERENCES

1. W.D. Stevenson, "Elements of Power System Analysis", TMH, 2017
2. S. M. Singh, "Electric power generation Transmission & Distribution", PHI, 2009.
3. Dr. S. L. Uppal, "Electrical Power", Khanna Publications, 2003.
4. B. R. Gupta, "Power System Analysis and Design", S. Chand, 2003.
5. G.Ramamurthy, "Handbook of Electrical power Distribution", Universities Press, 2013.

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CO3	3	2	3	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	3	-	-	-	-	-	-	-	-	-	-	2
CO5	-	3	-	-	-	-	-	-	-	-	-	-	-	2

EE16506 ELECTRICAL MACHINES II LABORATORY 0 0 4 2

COURSE OBJECTIVES

To enable the students to

- conduct relevant experiments for determining the performance characteristics of AC machines.
- calculate the regulation of three phase alternator using various methods.
- estimate the parallel operations of alternators.
- attain the V and inverted V curves of synchronous motors, forecast the performance characteristics of AC motors.

LIST OF EXPERIMENTS

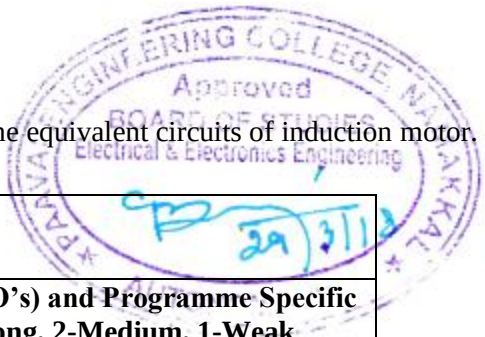
1. Regulation of three phase alternator by EMF and MMF methods
2. Regulation of three phase alternator by ZPF and ASA methods
3. Regulation of three phase salient pole alternator by slip test
4. Synchronization and parallel operation of alternators
5. V and Inverted V curves of three phase synchronous motor.
6. Load test on three-phase induction motor.
7. No load and blocked rotor test on three-phase induction motor
8. Separation of No-load losses of three-phase induction motor.
9. Load test on single-phase induction motor
10. No load and blocked rotor test on single-phase induction motor.
11. Load test on three phase alternator.

TOTAL PERIODS 60

COURSE OUTCOMES

At the end of this course, students will be able to

- compute the regulation of three phase alternator using various methods.
- evaluate the parallel operations of alternators.
- obtain the V and inverted V curves of synchronous motors.
- predict the performance characteristics of AC motors, obtain the equivalent circuits of induction motor.



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CO3	3	3	3	3	3	-	-	-	-	-	3	-	3	3
CO4	3	3	3	3	3	-	-	-	-	-	3	-	3	3

EE16507 **CONTROL SYSTEM LABORATORY** **0 0 4 2**

COURSE OBJECTIVES

To enable the students to

- acquire programming skills in the analysis and design of control systems.
- gain the knowledge for deriving transfer function of systems
- analyze the stability of systems
- test the performance of standard control equipments using analog simulation methods.

LIST OF EXPERIMENTS

1. Digital simulation of first and second order system
2. Stability Analysis of Linear systems by Routh-Hurwitz polynomial.
3. Stability Analysis of Linear systems by Root locus, Bode plot and Nyquist plot
4. Design of Lag and lead compensator.
5. Design of P, PI, PD, PID controllers.
6. Transfer function of DC and AC servomotor
7. Study of synchros**.**
8. Analog simulation of type 0 type 1system
9. Stepper motor control
10. Transfer function of armature controlled and field controlled DC Motor.
11. Transfer function of DC generator
12. AC and DC closed loop control system

TOTAL PERIODS 60

COURSE OUTCOMES

At the end of this course, students will be able to

- gain basic knowledge on simulation of control system
- design the feedback loop to achieve the desired output
- analyze the stability of systems
- investigate servo motor speed and position control principles

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CO3	3	3	3	3	3	-	-	-	-	-	3	-	3	3
CO4	3	3	3	3	3	-	-	-	-	-	3	-	3	3

EE16508 **POWER ELECTRONICS LABORATORY** **0 0 4 2**

(Common to EEE & MCT)

COURSE OBJECTIVES

To enable the students to

- study the characteristics of switching devices
- study the applications of rectifiers
- analyze performance of inverters and choppers
- design AC voltage controllers, and its controlling techniques.

LIST OF EXPERIMENTS

1. Characteristics of SCR and TRIAC.
2. Characteristics of MOSFET and IGBT.
3. Gate Pulse Generation using R, RC and UJT.
4. Voltage commutation.
5. Current commutation.
6. AC to DC half controlled converter.
7. AC to DC fully controlled converter.
8. Step down and step up MOSFET based choppers.
9. IGBT based single phase PWM inverter.
10. IGBT based three phase PWM inverter.
11. AC Voltage controller.
12. Cycloconverter.

TOTAL PERIODS 60

COURSE OUTCOMES

At the end of this course, students will be able to

- compare and contrast the performance and applications of various power semi converter devices.
- design the various phase controlled rectifiers with different loads.
- analyze the chopper circuit using MOSFET, IGBT and PWM inverters
- evaluate the performance of AC voltage converters.

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CO's	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	3	3	3	3	-	-	-	-	-	3	-	3	3
CO2	3	3	3	3	3	-	-	-	-	-	3	-	3	3
CO3	3	3	3	3	3	-	-	-	-	-	3	-	3	3
CO4	3	3	3	3	3	-	-	-	-	-	3	-	3	3

EN16501 CAREER DEVELOPMENT LABORATORY I 0 0 2 1

COURSE OBJECTIVES

To enable the students to

- understand their capabilities and enhance their grooming and showcasing his/ her capabilities to a prospective employer
- provide opportunity for the students to become acquainted with corporate opportunities relevant to their academic learning
- articulate their thoughts on a given topic in English and also to make decent write ups in English on any given topic
- practice and score well in Aptitude tests conducted by corporate / prospective employers
- prepare for any group discussion evaluation or presenting their credentials during a face- to-face interview leading to selection and employment

UNIT I BASIC SELF ANALYSIS 6

Introduction - Self Explorations: Who Am I, Personal Attributes, Self Confidence and Self Esteem - Communication Skills : Introduction to communication, Flow of communication, Listening, Barriers of communications, How to overcome the barriers of communications - Leadership Qualities : Skills for a good Leader, Leadership styles, SWOT Analysis, - Time Management: Time is a resource, Identify Time wasters, Time Management Styles, Techniques for better time management - Group Dynamics/ Team Building : Importance of group in organizations, Team Building, Interaction with the team, How to build the good team

UNIT II PERSONALITY DEVELOPMENT 6

Motivation : Introduction, Relevance and types of motivation, Analysis of motivation - Attitude : Factors, Influencing Attitude, Challenges and lessons from attitude - Creativity : Out of box thinking, Lateral thinking - Goal Setting : Wish list ; Blue print for success; Short, long, life time goals

UNIT III QUANTITATIVE APTITUDE 6

Number System - LCM & HCF - Square root & Cube root - Percentage - Time speed & Distance

UNIT IV QUANTITATIVE APTITUDE 6

Trains - Boats & Streams - Average - Ages - Area

UNIT V LOGICAL AND VERBAL REASONING 6

Series Completion : Number Series, Letter series, Symbol Series - Blood Relation - Coding and decoding - Logical Sequence - Analogy - Character Puzzles - Classification - Data sufficiency

TOTAL PERIODS 30

COURSE OUTCOMES

At the end of this course, students will be able to

- demonstrate aptitude and reasoning skills
- enhance verbal and written ability.
- improve his/her grooming and presentation skills.
- interact effectively on any recent event/happenings/ current affairs.
- be a knowledgeable person on the various evaluation processes leading to employment and face the same with Confidence.

REFERENCES

1. Agarwal, R.S." A Modern Approach to Verbal & Non Verbal reasoning", S.Chand& co ltd, New Delhi.
2. Abhijitguha, "Quantitative Aptitude ", Tata-Mcgraw hill.
3. word power made easy by normanlewis ,W.R.Goyal publications.
4. Johnson, D.W. Boston: Allyn and Bacon" reaching out – interpersonal effectiveness and self-actualization..
5. Agarwal, R.S." objective general English", S.Chand & co
6. "Infosys campus connect program – students" guide for soft skills.

CO-PO MAPPING:

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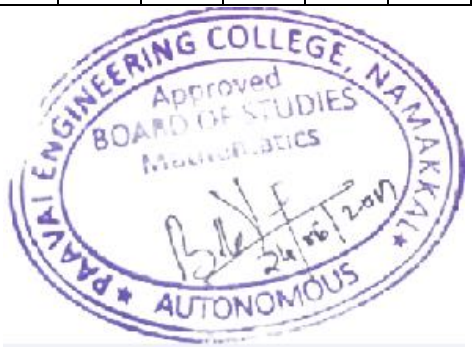
CO3	3	2	2	2	-	-	1	-	-	-	-	-	2	3
CO4	3	2	2	-	-	1	-	-	-	-	2	-	2	3
CO5	2	3	3	2	1	3	3	1	-	1	2	-	2	3



SEMESTER VI

EE16601 DESIGN OF ELECTRICAL APPARATUS 3 2 0 4

COURSE OBJECTIVES

To enable the students to

- study MMF calculation and thermal rating of various types of electrical machines.
- design the armature and field systems for D.C. machines.
- calculate the core, yoke, windings and cooling systems of transformers.
- design stator and rotor of induction machines
- analyze stator and rotor of synchronous machines and study their thermal behaviour.

UNIT I MAGNETIC CIRCUITS AND COOLING OF ELECTRICAL MACHINES 9+6

Concept of magnetic circuit - MMF calculation for various types of electrical machines - real and apparent flux density of rotating machines - leakage reactance calculation for transformers, induction and synchronous machine - thermal rating continuous, short time and intermittent short time rating of electrical machines.

UNIT II D.C. MACHINES 9+6

Constructional details - output equation - main dimensions - choice of specific loadings - choice of number of poles - armature design - design of field poles and field coil - design of commutator and brushes - losses and efficiency calculations.

UNIT III TRANSFORMERS 9+6

Introduction - output rating of single phase and three phase transformers - optimum design of transformers - design of core, yoke and windings for core and shell type transformers - equivalent circuit parameter from designed data - losses and efficiency calculations - design of tank and cooling tubes of transformers.

UNIT IV THREE PHASE INDUCTION MOTORS 9+6

Introduction - output equation - main dimensions - choice of Specific loadings - design of stator - design of squirrel cage and slip ring rotor - equivalent circuit parameters from designed data - losses and efficiency calculations.

UNIT V SYNCHRONOUS MACHINES 9+6

Introduction - output equation - choice of specific loadings - main dimensions - short circuit ratio - design of stator and rotor of cylindrical pole and salient pole machines - design of field coil - performance calculation from designed data - introduction to computer aided design.

TOTAL PERIODS 45+30=75

COURSE OUTCOMES

At the end of this course, students will be able to

- determine the MMF and thermal rating of electrical machine.
- design of D.C Machines.
- analyze and design the cooling system of transformer.
- design of induction machines.
- design of synchronous machine.

TEXT BOOKS

1. A.K. Sawhney, "A Course in Electrical Machine Design", DhanpatRai and Sons, New Delhi,2014.
2. S.K. Sen, "Principles of Electrical Machine Design with Computer Programmes", Oxford and IBH Publishing Co.Pvt Ltd., New Delhi, 2007.

REFERENCES

1. R.K. Agarwal, "Principles of Electrical Machine Design", S.K.Kataria and Sons, Delhi, 2014.
2. V.N. Mittle and A. Mittle, "Design of Electrical Machines", Standard Publications and Distributors, Delhi, 2012.
3. A.ShanmugaSundaram, G.Gangadharan, R.Palani "Electrical Machine Design Data Book", New AgeInternational Pvt. Ltd., Reprint, 2007.
4. M.V.Deshpande —"Design and Testing of Electrical Machine Design" Wheeler Publications, 2010.
5. K.G. Upadhyay, "Design of Electrical Machines", New Age International Publishers, 2008.

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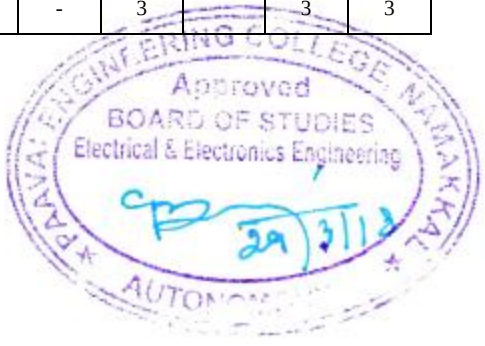
CO3	3	3	-	-	2	-	-	-	-	-	3		3	3
CO4	3	3	-	-	2	-	-	-	-	-	3		3	3
CO5	3	3	-	-	2	-	-	-	-	-	3		3	3



EE16602 SOLID STATE DRIVES 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand the stable steady-state operation and transient dynamics of a motor-load system.
- study and analyze the operation of the converter / chopper fed dc drive and to solve simple problems.
- learn and understand the operation of both classical and modern induction motor drives.
- comprehend the differences between synchronous motor drive and induction motor drive and to learn the basics of permanent magnet synchronous motor drives.
- analyze and design the current and speed controllers for a closed loop solid-state DC motor drive.

UNIT I CHARACTERISTICSOF ELECTRIC DRIVES 9

Electric Drives - Drive classification - Advantage of Electric Drives - Equations governing motor load dynamics Equilibrium operating point and its steady state stability - Mathematical condition for steady state stability - Selection of drives – Multi quadrant operation

UNIT II SOLID STATE CONTROL OF DC DRIVES 9

DC motor and their performance-Braking - Steady state analysis -Ward Leonard drives - Controlled rectifier fed DC drives - Chopper controlled DC drives - Time ratio control and current limit control - Four quadrant operation - Effect of ripples on the DC motor performance

UNIT III SOLID STATE CONTROL OF INDUCTION MOTOR DRIVES 9

Stator control- Steady state analysis - Stator voltage and frequency control - V/F control - Closed loop control of Voltage Source Inverter, Current Source Inverter and cycloconverter fed induction motor drives - Rotor control - Rotor resistance control and slip power recovery schemes- Sub synchronous and super synchronous operation - Closed loop speed control

UNIT IV SOLID STATE CONTROL OF SYNCHRONOUS MOTOR DRIVES 9

Types of synchronous Motors - Open loop v/f control -Self-controlled synchronous motor - Closed loop control Of Voltage Source Inverter, Current Source Inverter and cycloconverter fed synchronous motor drives - Margin angle control and power factor control - permanent magnet synchronous motor

UNIT V DESIGN OF CONTROLLERS FOR SOLID STATE DRIVES 9

Transfer function for DC motor/load and converter - closed loop control with Current and speed feedback - Armature voltage control and field weakening mode - Design of controllers; current controller and speed controller- converter selection and characteristics.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- obtain the stable steady-state and transient dynamics of a motor-load system.
- analyze the operation of the converter / chopper fed dc drive.
- perform analysis of classical and modern induction motor drives.
- differentiate between synchronous motor drive and induction motor drive.
- design the current and speed controllers for a closed loop solid-state DC motor drive.

TEXT BOOKS

1. Dubey.G.K., "Fundamental of Electrical Drives", Narosa publishing House, New Delhi 2010.
2. R.Krishnan, "Electric Motor & Drives: Modeling, Analysis and Control", Prentice Hall of India, 2009.

REFERENCES

1. Murphy, J.M.D and Turnbull.F.G. , "Thyristor control of AC Motors", Pergamon Press, New Delhi 2003
2. VedamSubramanyan, "Thyristor control of Electrical Drives", Tata McGraw Hill Publishing Combany, New Delhi 2007.
3. Gaekward, "Analog and Digital control systems", Wiley Eastern Ltd, New Delhi 2007
4. ShaahinFelizadeh, "Electric Machines and Drives", CRC Press (Taylor and Francis Group), 2013.
5. BimalK. Bose. "Modern Power Electronics and AC Drives", Pearson Education, 2002.

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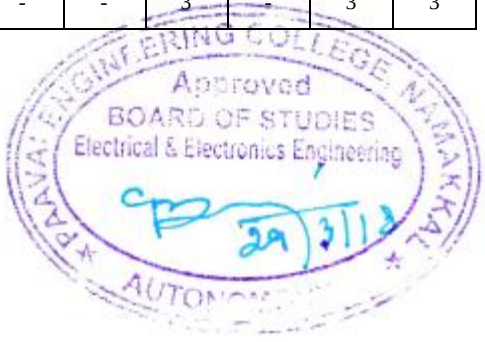
CO5	3	3	-	-	2	-	-	-	-	-	3	-	3	3



EE16603 POWER SYSTEM ANALYSIS 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- familiarize the different aspects of modeling of power system components.
- solve the power flow problems using efficient simulation and numerical methods.
- understand the concept of symmetrical and un symmetrical faults in power system studies.
- study the stability status of power system under transient condition.
- perform unsymmetrical fault analysis in power system

UNIT I THE POWER SYSTEM – AN OVERVIEW AND MODELING 9

Modern Power System - Basic Components of a power system - Per Phase Analysis-Generator model - Transformer model - line model - Per unit system -Change of base.

UNIT II POWER FLOW ANALYSIS 9

Introduction - Bus Classification - Bus admittance matrix - Solution of non-linear Algebraic equations - Gauss-Seidal method - Newton-Raphson method - Fast decoupled method - Flow charts and comparison of the three methods.

UNIT III FAULT ANALYSIS-BALANCED FAULT 9

Importance of short circuit analysis - assumptions in fault analysis - analysis using Thevenin‟s theorem - Z-bus building algorithm- fault analysis using Z-bus computations of short circuit capacity, post fault voltage and currents.

UNIT IV FAULT ANALYSIS SYMMETRICAL COMPONENTS AND UNBALANCED FAULT 9

Introduction - Fundamentals of symmetrical components - sequence impedances - sequence networks single line to ground fault - line-line fault - Double line to ground fault - Unbalanced fault analysis using bus impedance matrix.

UNIT V POWER SYSTEM STABILITY 9

Importance of stability analysis in power system planning and operation - classification of power system stability - angle and voltage stability - Single Machine Infinite Bus (SMIB) system: Development of swing equation - equal Area criterion - determination of critical clearing angle and time - solution of swing equation by modified Euler method and Runge-Kutta fourth order method

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- understand the modeling and analytical concepts of power system components in power systems.

- perform power flow analysis.
- solve for symmetrical faults in power system.
- compute unsymmetrical faults in power system.
- analyze the stability of power system.

TEXT BOOKS

1. I.J.Nagrath and D.P.Kothari, "Modern Power System Analysis", Tata McGraw-Hill publishing company, New Delhi, 2011.
2. P.Kundur, "Power System Stability and Control", Tata McGraw Hill Publishing Company, New Delhi, 2008.

REFERENCES

1. Olle. I. Elgerd, "Electric Energy Systems Theory – An Introduction", Tata McGraw Hill Publishing Company Limited, New Delhi, Second Edition, 2012.
2. Pai M A, "Computer Techniques in Power System Analysis", Tata McGraw-Hill Publishing Company Ltd., New Delhi, Second Edition, 2007.
3. J. Duncan Glover, Mulukutla S. Sarma, Thomas J. Overbye, "Power System Analysis & Design", CengageLearning, Fifth Edition, 2012.
4. John J. Grainger and W.D. Stevenson Jr., "Power System Analysis", Tata McGraw-Hill, Sixth reprint, 2010. Education, 2012.
5. P. Venkatesh, B.V. Manikandan, S. Charles Raja, A. Srinivasan, "Electrical Power Systems Analysis, Security and Deregulation", PHI Learning Private Limited, New Delhi, 2012.

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CO4	3	3	3	3	2	-	-	-	-	-	3	-	3	3
CO5	3	3	3	3	2	-	-	-	-	-	3	-	3	3

EE16604 MICROPROCESSORS AND MICROCONTROLLERS 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand the architecture of 8085 & 8086.
- study the addressing modes, instruction set and programming of 8085.
- introduce the need & use of interrupt structure of 8085.
- learn 8051 architecture, interrupts and serial communication.
- develop skill in simple program writing for 8051 and its applications.

UNIT I 8085 AND 8086 PROCESSOR 9

Hardware Architecture, pin diagram - Signals - Memory interfacing - I/O ports and data transfer concepts - Timing Diagram - Interrupt structure.

UNIT II PROGRAMMING OF 8085 PROCESSOR 9

Instruction format and addressing modes - Assembly language format - Data transfer, data manipulation & control instructions - Programming: Loop structure with counting & Indexing - Look up table - Subroutine instructions - stack.

UNIT III PERIPHERAL INTERFACING WITH 8085 9

Study of Architecture and programming of ICs: 8255 PPI, 8259 PIC, 8251 USART, 8279 Key board display controller and 8253 Timer/ Counter - Interfacing with 8085.

UNIT IV 8051 MICRO CONTROLLER 9

Functional block diagram - Instruction format and addressing modes - Interrupt structure - Timer - I/O ports - Serial communication.

UNIT V MICRO CONTROLLER PROGRAMMING & APPLICATIONS 9

Data Transfer, Manipulation, Control & I/O instructions - Simple programming exercises -key board and display interface - stepper motor control - Washing Machine Control.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- explain the architecture of 8085 microprocessor and write assembly language program.
- design the interfacing schemes of memory & peripheral devices with 8085 processor
- enumerate the architecture of 8086 microprocessor.
- develop the programming skills of 8051 microcontroller.
- perform investigation on microcontrollers application.

TEXT BOOKS

1. "Microprocessor and Microcontrollers", Krishna Kant Eastern Company Edition, Prentice – Hall of India, New Delhi, 2007.
2. Muhammad Ali Mazidi& Janice GilliMazidi, R.D.Kinely „The 8051 Micro Controller and Embedded Systems", PHI Pearson Education, 5th Indian reprint, 2003.
3. A.K. Ray and K.M. Bhurchandi, "Advanced Microprocessors and peripherals", 2nd Edition, Tata McGraw-Hill, 2006.

REFERENCES

1. R.S. Gaonkar, "Microprocessor Architecture Programming and Application", Wiley Eastern Ltd., New Delhi,2007.
2. "The 8088 & 8086 Microprocessors", Walter A Tribal &Avtar Singh, Pearson, 2007, Fourth Edition.
3. John E Uffenbeck, "The 80x86 Family, Design, Programming and Interfacing", Third Edition. Prentice Hall, 2001.
4. Douglas V.Hall, "Microprocessors and Digital Systems", McGraw Hill Publishing Co. Ltd. 2008
5. Kenneth J Ayala, "The 8051 Micro controller", Thomson Delmer Learning, 2004
6. William Kleitz, "Microprocessor and Micro Controller Fundamental of 8085 and 8051Hardware and Software", Pearson Education, 2010.

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CO4	3	3	3	3	2	-	-	-	-	-	3	-	3	3
CO5	3	-	-	3	-	-	-	-	-	-	3	-	3	3

EE16605 PROGRAMMABLE LOGIC CONTROLLERS 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- develop basic knowledge about PLC architecture.
- study the logical operation of ladder diagram.
- learn operation of peripheral devices used in the PLC.
- gain knowledge of the data handling methods.
- develop skill in simple program writing for PLC.

UNIT I PROGRAMMABLE LOGIC CONTROLLERS 9

Controllers- Hardware- Internal architecture- PLC systems- Input devices Output devices- Number systems: The binary system- Octal and hexadecimal- Binary arithmetic- PLC data- Input/output units- Signal conditioning- Remote connections- Processing inputs- I/O addresses

UNIT II LADDER AND FUNCTIONAL BLOCK PROGRAMMING & INTERNAL RELAYS 9

Ladder diagrams- Logic functions - Latching- Multiple outputs- Entering programs- Function blocks- Internal relays- Ladder programs - Battery-backed relays- One-shot operation- Set and reset- Master control relay

UNIT III TIMERS, COUNTERS AND REGISTERS 9

Types of timers - Programming timers- Off-delay timers- Pulse timers- Forms of counter- Programming- Up and down counting- Timers with counters - Sequencer- Shift registers- Ladder programs

UNIT IV DATA HANDLING AND DESIGNING SYSTEMS 9

Registers and bits- Data handling- Arithmetic functions- Closed loop control- Program development- Safe systems - Commissioning- Fault finding- System documentation

UNIT V PROGRAMMING APPLICATIONS 9

Temperature control- Valve sequencing- Conveyor belt control- Control of a process- Problems

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- explain the architecture of PLC.
- develop logical operation of ladder diagram in PLC.
- design various interfaces to the PLC.
- analyze the parameters of designing systems.
- gain adequate knowledge about various application of PLC

TEXT BOOKS

1. W. Bolton "Programmable Logic Controllers" Fourth Edition 2006
2. Petruzella"Industrial Electronics" McGraw Hill, 2010.
3. Michael P. Lukas, "Distributed Control System", Van Nostrand Reinhold Co.,Canada,2011

REFERENCES

1. Hughes, T.A "Programmable Controllers"- 4th Edition, ISA Press, 2005
2. John W Webb and Ronald A Reis —"Programmable Logic Controllers – Principles andApplications", Prentice Hall Inc., New Jersey, Third edition, 2003.
3. W. Bolton"Programmable Logic Controllers" Elsevier Newnes publications
4. E.A.Parr "Programmable Controllers An engineer"s guide" Elsevier Newnes publications

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CO5	3	2	2	-	2	3	2	2	3	-	2	1	1	1

EE16606 ELECTRICAL DRIVES LABORATORY 0 0 4 2

COURSE OBJECTIVES

To enable the students to

- understand and analyze the operation of induction and synchronous motor drives through simulation packages.
- control the speed of electrical drives using DSP and microcontrollers
- understand about speed control using dual converter
- know PLC drives

LIST OF EXPERIMENTS

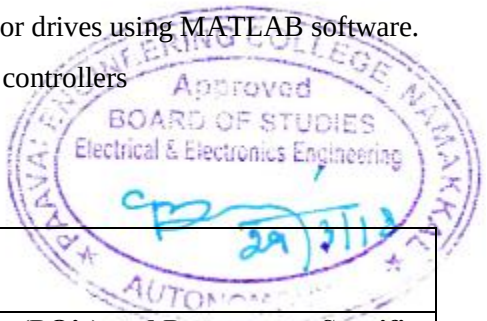
1. Simulation of VSI fed 3 phase induction motor.
2. Simulation of DC motor drive.
3. Speed control of DC motor using three phase rectifier.
4. Speed control of three phase induction motor using PWM inverter.
5. DSP based closed loop drive for induction motor.
6. Induction motor speed control using FPGA.
7. Speed control of brushless DC motor.
8. DSP based chopper fed DC motor drive.
9. Speed Control of DC Motor using dual converter.
10. PLC based drives.

TOTAL PERIODS 60

COURSE OUTCOMES

At the end of this course, students will be able to

- understand the operation of induction and synchronous motor drives using MATLAB software.
- control the speed of electrical drives using DSP and Micro controllers
- analyse speed control using dual converter
- implemenyt PLC drives



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CO4	3	3	3	3	3	1	-	-	-	-	3	-	3	3

EE16607 **MICROPROCESSORS AND MICROCONTROLLERS LABORATORY** **0 0 4 2**

COURSE OBJECTIVES

To enable the students to

- understand 8085 programming and instruction sets.
- interface8085 I/O interfacing peripheral devices such as keyboard, ADC, DAC and stepper motor with 8085.
- train 8051 programming and instruction sets.
- understand bit addressing in 8051 programming

LIST OF EXPERIMENTS

I. PROGRAMS USING 8085

1. 8 bit addition and subtraction
2. 8 bit multiplication and division
3. Sorting the given set of numbers in ascending and descending order
4. Finding the largest and smallest of given numbers
5. Code conversion
6. Interfacing with 8279
7. Interfacing with ADC & DAC
8. Interfacing with stepper motor

II.PROGRAMS USING 8051

1. 16 bit addition and subtraction
2. 16 bit multiplication and division
3. RAM direct addressing
4. Bit addressing

TOTAL PERIODS 60

COURSE OUTCOMES

At the end of this course, students will be able to

- develop programming skills in 8085 microprocessors and 8051 microcontroller, based on its instruction sets.
- develop programming skills to interface the Peripheral Devices with 8085 and 8051 hardware components
- Implement 8051 programming
- Interface devices using programming.

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CO2	3	3	-	-	-	-	-	-	-	-	3	-	3	3
CO3	3	3	3	3	3	1	-	-	-	-	3	-	3	3
CO4	3	3	3	3	3	1	-	-	-	-	3	-	3	3

EN16601 CAREER DEVELOPMENT LABORATORY II 0 0 2 1

COURSE OBJECTIVES

To enable the students to

- enhance career competency and employability skills
- demonstrate effective leadership and interpersonal skills
- improve professional capabilities through advanced study and researching current market strategy.
- develop problem solving and decision making capabilities
- improve their reasoning skills to get placed in reputed companies

UNIT I CORPORATE READINESS 6

Business communication - Email, Paragraph, Letter Writing Skills - Public speaking skills : Rules of Public speaking skills; Extempore, JAM - Inter and intra personal skills : Introduction ; Need for Inter and Intra personal skills in organizations - Stress management : Causes of stress and its impact, How to manage and distress, Circle of control, stress busters - Emotional Intelligence : What is emotional Intelligence, Why Emotional Intelligence Matters, Managing Emotions

UNIT II INTERVIEW SKILLS 6

Interview Basics : General Selection process, Grooming, Dress code, Supporting Documents to carry - Resume Building : Impact of Powerful CV, Do‟s and don‟ts in CV - Group Discussion : Introduction to GD, Important of Listening and Speaking skills, Do‟s and Don‟ts in GD - Face to face interview / Hire me: Rules for face to face interview, body language, Self-Introduction - Psychometric Assessment : Importance of Psychometric assessment, Why psychometric assessment

UNIT III QUANTITATIVE APTITUDE 6

Simplification - Time and work - Pipes and cisterns - Ratio and Proportion - Partnership

UNIT IV QUANTITATIVE APTITUDE 6

Simple interest and Compound interest - Profit and loss - Permutation and combinationProbability - Calendar

UNIT V LOGICAL AND VERBAL REASONING 6

Seating arrangement - Direction - Arithmetic reasoning - Syllogisms - Making Judgments - Statements and conclusions - Matching definition - Cause and effect

TOTAL PERIODS 30

COURSE OUTCOMES

At the end of this course, students will be able to

- develop team work capabilities
- boost their problem solving skills
- enhance the transformation from college to corporate.
- compute problems based on quantitative aptitude
- reveal their logical and verbal reasoning by scoring the expected percentage to get placed in reputed companies

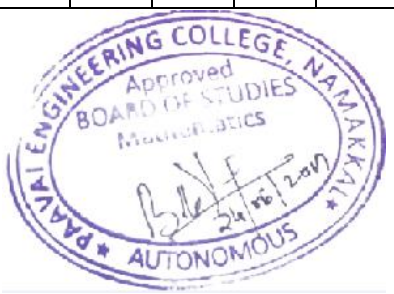
REFERENCES

1. Agarwal, R.S.”a modern approach to verbal &non verbal reasoning”, , S.Chand& co ltd, New Delhi.
2. Abhijitguha, “quantitative aptitude for competitive examinations”, Tata Mcgraw hill
3. “Word power made easy” by normanlewis ,wr.goyal publications.
4. Johnson, D.W. (1997). “Reaching out – interpersonal effectiveness and self Actualization” -- Boston: Allyn and bacon.
5. “Infosys Campus Connect Program – student” guide for soft skills.
6. Mitra ,barun.K, “ Personalaity Development &Softskills “ , Oxford University.

CO-PO MAPPING:

Mapping of Course Outcome (CO’s) with Programme Outcomes (PO’s) and Programme Specific Outcomes PSO’s (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

	PO’s												PSO’s	
CO’s	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	2	2	3	3	1	-	-	-	-	-	-	3	2
CO2	-	2	3	-	2	-	2	-	-	-	-	-	3	2
CO3	3	2	2	2	-	-	1	-	-	-	-	-	2	3
CO4	3	2	2	-	-	1	-	-	-	-	2	-	2	3
CO5	2	3	3	2	1	3	3	1	-	1	2	-	2	3



PROGRAMME ELECTIVE I

EE16151 BIO MEDICAL ENGINEERING 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand the knowledge about the organs of human body and measure the parameters
- learn the bio potential electrodes, transducers and their types
- gainthe knowledge about the various measurements of blood pressure.
- study about the modern imaging systems.
- know the latest technologies in biomedical engineering.

UNIT I ELECTRO PHYSIOLOGY 9

Cell and Its Structure - Electrical, Mechanical and Chemical Activities - Action and Resting Potential- Organization of Nervous System - CNS - PNS - Neurons - Axons - Synapse - Propagation of Electrical Impulses along the Nerve - Sodium Pump - Cardio Pulmonary System- Physiology of Heart, Lung, Kidney.

UNIT II BIO POTENTIAL ELECTRODES AND TRANSDUCERS 9

Design of Medical Instruments - Components of Biomedical Instrument System - Electrodes: Micro Electrodes, Needle Electrodes, Surface Electrodes - Transducers -Piezo Electric, Ultrasonic, Passive Transducers - Resistive, Capacitive, Inductive - Biomedical Measurements Like PH, PCO2, PO2 of Blood, Isolation Amplifier, Preamplifier, Current Amplifier, Chopper Amplifier.

UNIT III INSTRUMENTS USED FOR DIAGNOSIS 9

ECG, Einthoven Triangle, Leads, Electrodes, Vector Cardiograph, Measurement of Cardiac Output, EEG, EMG, Plethysmography, Blood Flow Measurements, Holter Monitor- Respiratory Rate Measurement - Oximeter, Patient Monitoring System, ICCU.

UNIT IV MODERN IMAGING SYSTEM 9

Ultrasonic Diagnosis, Ultrasonic Scanning, Isotopes in Medical Diagnosis - Pace Makers, Defibrillators, Doppler Monitor(colour), Medical imaging-X-ray generation, Radiographic & Fluoroscopic Techniques - Image Intensifiers-Computer Aided Tomography, PET, SPECT- Laser Applications – Echocardiography-CT Scan-MRI/NMR-Endoscopy.

UNIT V RECENT TRENDS & INSTRUMENTS FOR THERAPY 9

Dialysers - Surgical Diathermy - Electro Anaesthetic and Surgical Techniques, Sources of Electric Hazards and Safety Techniques. Single Channel Telemetry, Multi-channel Telemetry, Implantable Telemetry, Wireless Telemetry, Telemedicine, Telemedicine Applications.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- acquaint the physiology of the heart, lung, blood circulations, respirations, patient monitoring and electrical safety in clinical environment.
- apply the proper electrodes and transducers based on the application.
- obtain the knowledge in various electrical origins of recording methods of ECG, EEG, EMG, ERG
- know how to use the latest medical equipments available for measurement of non-electrical parameters in the physiological systems of the human body and also the modern methods of imaging techniques used for diagnostic purpose in the health care centre
- identify the latest procedure adopted for providing Medical assistance through Telemedicine and the Therapeutic equipments used for diagnostic and surgery purposes.

TEXT BOOKS

1. Khandpur, "Handbook of Biomedical Instrumentation" 2nd Edition, Tata McGraw Hill, 2003.
2. M.Arumugam, "Biomedical Instrumentation", Anuradha Publications, Reprint 2009.

REFERENCES

1. Leslie Cromwell, Fred J. Werbell and Eruch A. Pfeigger, "Biomedical Instrumentation and Measurements" 2nd Edition 2011
2. WQ. J.Tompskins and J.G. Webster, Design of Microcomputer Based Medical Instrumentation Prentice-Hall, 2000.
3. Geddes and Baker, Principle of Applied Biomedical Instrumentation John Wiley and Sons, New York, 2001.
4. John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, India, 3rd Edition, 2013.
5. Geddes L.A. and Baker L.E., "Principles of Applied Bio-Medical Instrumentation", John Wiley & Sons, 3rd. Edition, 2013

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

	Programme Outcomes PO's												PSO's	
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CO2	3	2	2	-	-	2	2	-	-	-	2	2	2	2
CO3	3	2	2	-	-	2	-	-	-	-	2	2	2	2
CO4	3	2	2	-	-	2	-	-	-	-	2	2	2	2
CO5	3	2	2	-	-	2	-	-	-	-	2	2	2	2

EE16152 ELECTRICAL SAFETY 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- impart knowledge on the basic concepts of electrical safety
- acquaint to the concepts of electrical safety.
- understand the protection systems for electrical equipments.
- learn the installation, operation and maintenance of electrical circuits.
- gain knowledge on the hazards and issues.

UNIT I CONCEPTS AND STATUTORY REQUIREMENTS 9

Introduction - electrostatics, electro magnetism, stored energy, energy radiation and electromagnetic interference - Working principles of electrical equipment-Indian electricity act and rules- statutory requirements from electrical inspectorate-international standards on electrical safety - first aid - cardio pulmonary resuscitation(CPR).

UNIT II ELECTRICAL HAZARDS 9

Primary and secondary hazards-shocks, burns, scalds, falls-human safety in the use of electricity. Energy leakage- clearances and insulation- classes of insulation - voltage classifications - excess energy -current surges-Safety in handling of war equipment‟s- over current and short circuit current-heating effects of current-electromagnetic forces-corona effect - static electricity - definition, sources, hazardous conditions, control, electrical causes of fire and explosion-ionization spark and arc - ignition energy - national electrical safety code ANSI. Lightning, hazards, lightning arrestor, installation - earthing, specifications, earth resistance, earth pit maintenance.

UNIT III PROTECTION SYSTEMS 9

Fuse, circuit breakers and overload relays - protection against over voltage and under voltage - safe limits of amperage - voltage - safe distance from lines - capacity and protection of conductor - joints - and connections, Over load and short circuit protection - no load protection - earth fault protection. FRLS insulation -insulation and continuity test - system grounding - equipment grounding - earth leakage circuit breaker (ELCB) - cable wires - maintenance of ground - ground fault circuit interrupter - use of low voltage-electrical guards - Personal protective equipment - safety in handling hand held electrical appliances tools and medical equipments

UNIT IV SELECTION, INSTALLATION, OPERATION AND MAINTENANCE 9

Role of environment in selection -safety aspects in application-protection and interlock-self diagnostic features and fail safe concepts - lock outand work permit system-discharge rod and earthing devices - safety in the use of portable tools- cabling and cable joints -preventive maintenance.

UNIT V HAZARDOUS ZONES **9**

Classification of hazardous zones - intrinsically safe and explosion proof electrical apparatus -increase safe equipment - their selection for different zones - temperature classification - grouping of gases - use of barriers and isolators - equipment certifying agencies.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- apply the basic concepts of electrical safety during practical‟s
- explain concepts of electrical safety.
- use the appropriate protection systems for electrical equipments.
- enumerate the installation, operation and maintenance of electrical circuits.
- discusson the hazards and issues.

TEXT BOOKS

1. Fordham Cooper, W., “Electrical Safety Engineering” Butterworth and Company, London, 2010.

REFERENCES

1. N.S.C.,Chicago, “Accident prevention manual for industrial operations”, 2009.
2. Indian Electricity Act and Rules, Government of India.
3. “Power Engineers–Handbook of TNEB”, Chennai, 2011.
4. Martin Glov, “Electrostatic Hazards in powder handling, Research Studies” Pvt.Ltd., England, 2013.

CO-PO MAPPING:

Mapping of Course Outcome (CO’s) with Programme Outcomes (PO’s) and Programme Specific Outcomes PSO’s (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO’s	Programme Outcomes PO’s												PSO’s	
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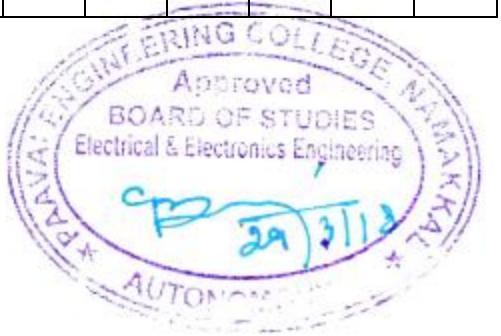
CO2	3	2	3	-	-	2	2	-	-	-	2	2	2	2
CO3	3	2	3	-	-	2	-	-	-	-	2	2	2	2
CO4	3	2	3	-	-	2	-	-	-	-	2	2	2	2
CO5	3	2	3	-	-	2	-	-	-	-	2	2	2	2



EE16153 DIGITAL CONTROL ENGINEERING 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- impart knowledge on the digital control systems and pulse transfer function
- acquaint to the concepts of state variable approach for the analysis of discrete time systems
- understand the concepts of stability analysis of discrete time systems
- obtain the solutions of state equations.
- gain knowledge on the design of controllers for digital design

UNIT I INTRODUCTION 9

Introduction - closed loop sampled data control system - typical digital control systems - sampling theorem - sample and hold operation - advantages of sampling - pulse transfer function - Z-domain equivalence to S- domain.

UNIT II STATE SPACE ANALYSIS 9

Advantages of State model - State Space model-Companion Canonical Form, Canonical form, Jordan Canonical form - State diagram

UNIT III STABILITY ANALYSIS 9

Stability analysis - Jury stability test - Bilinear transformation method - root locus method - effect of pole zero configuration in Z-plane - dominant pole concept - transient response of sampled data control systems

UNIT IV SOLUTIONS TO STATE EQUATIONS 9

Eigen values and eigen vectors-Solutions of State equations - Laplace transformation technique, Cayley Hamilton Method - Transfer function from State equations-concepts of controllability and observability

UNIT V DESIGN 9

Transform of digital control system - Design specifications - Design on the W plane- Digital PID controller - Introduction to design on the Z plane.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- describe the digital control systems and pulse transfer function
- obtain the state model of systems.
- determine the stability of discrete time systems
- obtain the solutions of state equations.
- design controllers for digital design.

TEXT BOOKS

1. Gopal M, “Digital Control Engineering”,Wiley Eastern Publishers, 1997.
2. Kuo B C, “Digital control system”, Prentice Hall.PA, 1996

REFERENCES

1. K. P. Mohandas, “Modern Control Engineering”, Sanguine Technical Publishers, 2006
2. Farzad Nekoogar, Genemoriarty, “Digital control usingDSP”, Prentice Hall Pvt.Ltd, 2010.
3. Richard C.Dorf, Robert H.Bishop, “Modern Control systems”, Addison Wesley, 2013.
4. Michael P Lukas, “Distributed Control Systems”, Van NostrandReinhold Company, New York, 2009.
5. K. Ogata, “Modern Control Engineering”, Pearson Education, New Delhi, 2009.

CO-PO MAPPING:

Mapping of Course Outcome (CO’s) with Programme Outcomes (PO’s) and Programme Specific Outcomes PSO’s (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

	Programme Outcomes PO’s												PSO’s	
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CO2	3	2	3	-	-	2	2	-	-	-	2	2	2	2
CO3	3	2	3	-	-	2	-	-	-	-	2	2	2	2
CO4	3	2	3	-	-	2	-	-	-	-	2	2	2	2
CO5	3	2	3	-	-	2	-	-	-	-	2	2	2	2

EE16154 NANO SCIENCE 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- impart knowledge on the basics about the semiconductor & optoelectronic materials.
- know about the nano structure semiconducting materials.
- understand the different applications of nano semiconductor & nano magnetic particles in different area
- have an insight on the characteristics of nano composites and zeolites.
- comprehend the characterization of polymers.

UNIT I CONCEPTS OF NANOSTRUCTURES 9

Electronic states in crystal energy bands, Concepts of 2D nanostructures (quantum wells), 1 D nano structures (quantum wires) 0D nanostructures (quantum dots), artificial atomic clusters.

UNIT II PROPERTIES AND ANALYSIS OF NANOSTRUCTURES 9

Size dependent properties, Size dependent absorption spectra, Blue shift with smaller sizes, Phonons in nanostructures, Contacts at Nano level, AFM. lSTM tip on a surface.

UNIT III ANALYSIS OF QUANTUM TECHNIQUES 9

Charging of quantum dots, Coulomb blockade, Quantum mechanical treatment of quantum wells, wires and dots, Widening of band gap in quantum dots, Strong and weak confinement, Properties of coupled quantum dots, Optical scattering from Nan defects.

UNIT IV CHARACTERISTIC OF NANO COMPOSITES AND ZEOLITES 9

Nano composites Electronic and atomic structure of aggregates and nano particles theory and modeling of nano particles fictionalization processes.

UNIT V CHARACTERIZATION OF NANOPOLYMERS 9

Nano systems: Synthesis and characterization Methods of Synthesis: Molecular beam epitaxy, MOCVD, chemical routes, nano particles on polymers, pulsed laser deposition, ion beam assisted techniques including embedded nano particles, RF sputtering.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- explain the concept of nano physics anf quantum dots.
- determinethe behavior of materials at nano scale
- analyze the energy level to different materials
- analyze the characteristics of nano composite materials.

- give details about the synthesis of polymer and their characteristics

TEXT BOOKS

1. K.Bamam and D.Vvedensky ,"Low Dimensional Semiconductor Structures", 2011.
2. B. H. Bransden, Charles Jean Joachain "Quantum Mechanics" Prentice Hall, 2010

REFERENCES

1. L.Banyai and S.W.Koch ,"Semiconductor Quantum Dots", (World Scientific) 2010,
2. J.H. Davies, "An introduction to the physics-af low dimensional semiconductors", Cambridge Press, 2008.
3. Karl Goser, Peter Glosekotter, Jan Dienstuhl "Nanoelectronics and Nanosystems" , Springer, 2004
4. Krause P. C. and Wasynczuk O., "Electromechanical Motion Devices", McGraw-Hill, New York, 2009.
5. Lyshevski S. E., "Integrated control of microactuators and integrated circuits: a new turning approach in MEMS \technology," Proceedings Conference Decision and Control", Phoenix, AZ, pp. 2611-2616, 2009.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	PO's												PSO's	
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CO1	3	2	3	2	-	2	-	-	-	-	2	2	2	2
CO2	3	2	3	-	-	2	2	-	-	-	2	2	2	2
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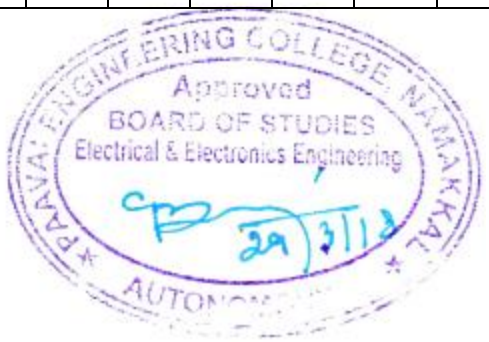
CO5	3	2	3	-	-	2	-	-	-	-	2	2	2	2



EE16155 NETWORK ANALYSIS AND SYNTHESIS 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand the concept of S-domain network.
- know the concept of frequency response.
- learn the concept of network topology.
- have an indepth knowledge on the design of two-port networks and filters.
- synthesize an electrical network from a given impedance/admittance function.

UNIT I S-DOMAIN ANALYSIS 9

S-domain network -driving point and transfer impedances and their properties - transform network analysis - Time response of series RC, RL and RLC circuits

UNIT II FREQUENCY DOMAIN ANALYSIS 9

Immittance - loci of RLC network - Frequency response of three phase RLC networks - frequency response from pole- zero- Bode plots

UNIT III NETWORK TOPOLOGY 9

Network graph, tree and cut-sets - tie set and cut-set schedules - v-shift and I-shift - Primitive impedance and admittance matrices -Application to network solutions.

UNIT IV TWO-PORT NETWORKS AND FILTERS 9

Characterization of two-port networks in terms of z, y, h-and T-parameters - Network Equivalents -Relations between network parameters - Analysis of T, ladder, bridged - T and lattice networks -Transfer function of terminated two - port networks. Filters and attenuators - Design of constant -k, m-derived and composite filters -qualitative treatment of active filters -Butterworth and Chebyshev filters.

UNIT V ELEMENTS OF NETWORK SYNTHESIS 9

Realisability of one-port network - Hurwitz polynomials and properties - Positive real functions and properties -synthesis of RL, RC and LC one-port networks

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- perform analysis of electrical circuits in s domain
- analyze electric circuits in frequency domain.
- apply network topology to find the electrical parameters.
- examine two port networks and design constant K and m derived filters.
- synthesize one port electrical circuits.

TEXT BOOKS

1. Kuo. F.F., "Network Analysis and Synthesis", Wiley International Edition, Second Edition, 2010.
2. Wadhwa C L "Network analysis and synthesis" New Age International publishers (P) ltd., Second edition, Delhi. 2016.

REFERENCES

1. Paranjothi,S.R., "Electric Circuit Analysis", New age International Publishers, Second Edition, 2017.
2. Van Valkenburg, M.E., "Network Analysis", Prentice-Hall of India Private Ltd., New Delhi, Third Edition. 2014.
3. ShyamMohan S.P., Sudhakar A, "Circuits and Network Analysis &Synthesis", Tata McGraw Hill, 2011.
4. Arumugam .M and Premkumar .N, "Electric circuit theory", Khanna& Publishers, 2006.
5. Soni M.L and Gupta J.C, "Electrical circuit Analysis", DhanpatRai and Sons, Delhi, 1990.

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CO's	Programme Outcomes PO's												PSO's	
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CO4	3	2	3	-	-	2	-	-	-	-	2	2	2	2
CO5	3	2	3	-	-	2	-	-	-	-	2	2	2	2

OPEN ELECTIVE I

EE16901 MICRO ELECTRO MECHANICAL SYSTEM 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- study the basics of MEMS and parts of MEMS
- understand the sensors and transducers used in MEMS.
- know design methodology of MEMS for various mechanics
- learn the process of lithography in MEMS
- identify the applications of optical and RF based MEMS.

UNIT I INTRODUCTION 9

MEMS- Micro fabrications for MEMS - Surface micromachining of silicon - Wafer bonding for MEMS - LIGA process - Micromachining of polymeric MEMS devices -Three-dimensional micro fabrications. Materials: Materials for MEMS - Metal and metal alloys for MEMS - Polymers for MEMS - Other materials for MEMS. Metal: Evaporation - Sputtering. Semiconductors: Electrical and chemical properties-Growth and deposition. Thin films for MEMS and their deposition techniques.

UNIT II MICROSENSING FOR MEMS 9

Piezo-resistive sensing - Capacitive sensing - Piezoelectric sensing - Resonant sensing -Surface acoustic wave sensors. Transducers: Electromechanical transducers - Piezoelectric transducers -Electrostrictive transducers - Magnetostrictive transducers - Electrostatic actuators-Electromagnetic transducers - Electrodynamic transducers - Actuators: Electrothermal actuators-Comparison of electromechanical actuation schemes.

UNIT III MICRO MACHINING 9

Micromachining : Bulk micromachining for silicon-based MEMS -Isotropic and orientation-dependent wet etching - Dry etching - Buried oxide process - Silicon fusion bonding - Anodic bonding - Silicon surface micromachining Sacrificial layer technology - Material systems in sacrificial layer technology - Surface micromachining using plasma etching -Combined integrated-circuit technology and anisotropic wet etching

UNIT IV LITHOGRAPHY 9

Micro stereo lithography for polymer MEMS - Scanning method -Two-photon micro stereo lithography Surface micromachining of polymer MEMS - Projection method - Polymeric MEMS architecture with silicon, metal and ceramics - Microstereolithography integrated with thick film lithography

UNIT V APPLICATIONS **9**

Switching: Introduction - Switch parameters - Basics of switching - Mechanical switches -Electronic switches - Switches for RF and microwave applications - Mechanical RF switches - PIN diode RF switches - Metal oxide semiconductor field effect transistors and monolithic microwave integrated circuits. RF MEMS switches: Integration and biasing issues for RF switches -Actuation mechanisms for MEMS devices-Electrostatic switching.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- integrate the knowledge of semiconductors and solid mechanics MEMS device fabrication.
- understand the rudiments of micro fabrication techniques
- identify and understand the various sensors and actuators
- select different materials used for MEMS
- apply MEMS to various disciplines

TEXT BOOKS

1. Vijay K.Varadan, K.J.Vinoy and K.A.Jose, "RF MEMS and Their Applications(ISBN 0-470-84308-X)", 1st Edition, John Wiley &SonsLtd., West Sussex, England, 2003.
2. James J.Allen, "Micro electro mechanical system design", CRC Press published in 2005

REFERENCES

1. P. Rai-choudhury, "MEMS and MEMS Technology and Applications", 1st Edition PHI, 2009.
2. S. Senturia, "Microsystem Design", Kluwer, 2001.
3. J.W. Gardner, V.K. Varadan, O.O. Awadelkarim, "Microsensors, MEMS & Smart Devices"John Wiley,2013.
4. S. Campbell, "The Science and Engineering of Microelectronic Fabrication", Oxford Univ. Press, 2001
5. Tai Ran Hsu, "MEMS & Micro systems Design and Manufacture" Tata McGraw Hill, New Delhi, 2007.

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CO4	3	2	3	-	-	2	-	-	-	-	2	2	2	2
CO5	3	2	3	-	-	2	-	-	-	-	2	2	2	2

EE16902 INDUSTRIAL ROBOTICS 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- learn robotic technology
- understand about the peripherals used and vision process
- get idea about programming of robots.
- know the robotic applications in different industrial domains

UNIT I INTRODUCTION 9

Automation and robotics, Robotic System and Anatomy Classification, Future Prospects - Drive: Control Loops, Basic. Control System Concepts and Models, Control System Analysis, Robot Activation and Feedback Components, Position and Velocity Sensors, Actuators , Power Transmission Systems

UNIT II PERIPHERAL, SENSORS AND MACHINE VISION 9

End Effecters - types, Mechanical and other grippers, Tool as end effecter - sensors: Sensors in Robotics, Tactile Sensors, Proximity and Range Sensors, Sensor Based Systems, Uses Vision Systems - Equipment-introduction, Low level and High level vision, Sensing and Digitizing, Image processing and analysis, Segmentation, Edge detection, Object description and recognition, Interpretation, Applications

UNIT III PROGRAMMING FOR ROBOTS 9

Methods, Robot programme as a path in space, Motion interpolation, level and task level languages, Robot languages; Programming in suitable languages Characteristics of robot.

UNIT IV ROBOT KINEMATICS AND APPLICATION 9

Forward, Reverse - Homogeneous Transformations, Manipulator Path Control, Robot Dynamics

UNIT V ROBOTIC APPLICATION IN MANUFACTURING 9

Material transfer, Machine loading and unloading, Processing operations, Assembly and Inspectors, Robotic Cell Design and Control.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- explain the basic principles of robotic technology, configurations, control and programming of robots.
- design an industrial robot which can meet kinematic and dynamic constraints.
- choose the appropriate sensor and machine vision system for a given application.
- clarify the basic principles of programming and apply it for typical Pick & place, loading & unloading and palletizing applications.

TEXT BOOKS

1. Fu, Lee and Gonzalez "Robotics, control vision and intelligence". McGraw Hill International, 2nd edition, 2007.
2. John J. Craig, "Introduction to Robotics" Addison Wesley Publishing, 3rd edition, 2010.

REFERENCES

1. M.P. Groover , M. Weiss, R.N. Nagel, N.G. Odrey "INDUSTRIAL ROBOTICS,"Mcgra – Hill International. 2007
2. YoramKoren, "Robotics for Engineers" McGraw Hill International, 1st edition, 2011.
3. Groover, Weiss, Nagel,"Industrial Robotics" McGraw Hill International, 2nd edition, 2012.
4. Klafter, Chmielewski and Negin, "Robotic Engineering - An Integrated approach", PHI, 1st edition,
5. YoremKoren, "Robotics for Engineers"2009.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

	Programme Outcomes PO's												PSO's	
CO's	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	3	2	-	2	-	-	-	-	2	2	2	2
CO2	3	2	3	-	-	2	2	-	-	-	2	2	2	2
CO3	3	2	3	-	-	2	-	-	-	-	2	2	2	2
CO4	3	2	3	-	-	2	-	-	-	-	2	2	2	2
CO5	3	2	3	-	-	2	-	-	-	-	2	2	2	2

EE16903 SOFT COMPUTING TECHNIQUES 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand the artificial intelligence, various types of production systems, characteristics of production systems.
- expose the neural networks, architecture, functions and various algorithms involved.
- learn the basic fuzzy logic functions, various fuzzy systems and their functions.
- Study the fuzzy set theory based on applications.
- Know the genetic algorithms, its applications and advances.

UNIT I NEURAL NETWORKS-I 9

Artificial neural networks - definition and fundamental concepts - engineering approaches to neural computing- biological neural networks - Artificial neural activation functions - setting of weights - typical architectures - biases and thresholds - learning and its methods - LMS learning rule - MADALINE - XOR Problem - training algorithm. Supervised Learning Neural Networks - Perceptrons - Adaline - Back propagation Mutilayer Perceptrons

UNIT II NEURAL NETWORKS-II 9

Radial Basis Function Networks - Support Vector Machines - Unsupervised Learning Neural Networks - Competitive Learning Networks - Kohonen Self-Organizing Networks - Learning Vector Quantization - Hebbian Learning.

UNIT III FUZZY SET THEORY-I 9

Introduction to Neuro - Fuzzy and Soft Computing - Fuzzy Sets - Basic Definition and Terminology - Set-theoretic Operations - Member Function Formulation and Parameterization - Fuzzy Rules and Fuzzy Reasoning - Extension Principle and Fuzzy Relations - Fuzzification and Defuzzification

UNIT IV FUZZY SET THEORY-II 9

Fuzzy If-Then Rules - Fuzzy Reasoning - Fuzzy Inference Systems - Mamdani Fuzzy Models -Sugeno Fuzzy Models - Tsukamoto Fuzzy Models - Input Space Partitioning and Fuzzy Modeling.

UNIT V GENETIC ALGORITHM 9

Introduction to genetic algorithm-history - basic concepts-creation of offspring-working principle-encoding-binary encoding-octal encoding - hexadecimal encoding - permutation encoding - value encoding - tree encoding-fitness function. Application of GA in power system optimization problems, AC drives, DC drives, neuro - GA applications, GA based optimal weight training for neural networks

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- explain about soft computing techniques and their applications
- analyze various neural network architectures
- define the fuzzy systems
- perform analysis of systems based on fuzzy set theory.
- examine the genetic algorithms and their applications.

TEXT BOOKS

1. Laurance Fausett, Englewood cliffs, N.J., "Fundamentals of Neural Networks", Pearson Education,2008.
2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", Tata McGraw Hill, 2007.

REFERENCES

1. Simon Haykin, "Neural Networks", Pearson Education, 2003.
2. John Yen & Reza Langari, "Fuzzy Logic – Intelligence Control & Information", Pearson Education, New Delhi, 2003
3. M.Gen and R,Cheng, "Genetic algorithms and Optimization", Wiley Series in Engineering Design and Automation, 2000
4. Hagan, Demuth, Beale, "Neural Network Design", Cengage Learning, 2012.
5. N.P.Padhy, "Artificial Intelligence and Intelligent Systems", Oxford, 2013.

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Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

	Programme Outcomes PO's												PSO's	
CO's	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	-	-	-	2	3	1	-	1	-	2	1	-	2
CO2	3	-	-	-	2	3	1	-	1	-	2	1	-	2
CO3	3	-	-	-	2	3	1	-	1	-	2	1	-	2
CO4	3	-	-	-	2	3	1	-	1	-	2	1	-	2
CO5	3	-	-	-	2	3	1	-	1	-	2	1	-	2

EE16904 WIND AND SOLAR ENERGY SYSTEMS 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- impart knowledge on the energy availability in the field renewable energy.
- acquire knowledge about the wind generators and about wind hybrid technology.
- understand the developing processes involved in wind energy system.
- impart detailed knowledge on photovoltaic system and role of power electronics in PV system.
- get basic idea of hybrid wind and solar system.

UNIT I INTRODUCTION 9

Recent trends in energy consumption - World energy scenario - Energy sources and their availability - Qualitative study of different renewable energy resources: Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems - need to develop new energy technologies

UNIT II WIND ENERGY CONVERSION SYSTEMS 9

Basic principle of wind energy conversion - nature of wind - Wind survey in India - Power in the wind - components of a wind energy - conversion system - Performance of induction generators for WECS - classification of WECS - Analysis of different wind power generators - IG - PMSG - DFIG – SEIG.

UNIT III GRID CONNECTED WIND ENERGY SYSTEMS 9

Grid Connected WECS: Grid connectors concepts - wind farm and its accessories - Systems for Feeding into the Grid - Induction Generators for Direct Grid Coupling - Asynchronous Generators in Static Cascades - Synchronous. Generators Grid related problems - Generator control - Performance improvements - Different schemes - AC voltage controllers - Harmonics and PF improvement

UNIT IV SOLAR ENERGY CONVERSION SYSTEMS 9

Photovoltaic Energy Conversion: Solar radiation and measurement - solar cells and their characteristics - PV arrays - Electrical storage with batteries - Switching devices for solar energy conversion Grid connection Issues - Principle of operation: line commutated converters (inversion-mode) - Boost and buck-boost converters- selection of inverter, battery sizing, array sizing. PV Applications: Standalone inverters - Charge controllers - Water pumping, audio visual. equipments, street lighting - analysis of PV systems

UNIT V OPERATION OF POWER SYSTEM WITH WIND AND SOLAR ENERGY SYSTEMS **9**

Interface requirement - synchronizing with grid - operating limit - energy storage and load scheduling - utility Resource planning - electrical performance - voltage, current and power efficiency - component design for maximum efficiency - static bus impedance and voltage regulation - quality of power - renewable capacity limit - Plant economy

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- describe about the fundamentals of wind and solar energy and the requirements of renewable energy in India
- find various wind turbines and importance of hybrid wind energy system
- design wind energy systems
- enumerate about the principle of conversion of solar energy through power electronics converters
- acquire knowledge about the importance of hybrid wind and solar system

TEXT BOOKS

1. Rai ,G.D., "Non- conventional resources of energy" , Khanna publishers ,Fourth edition , 2010.

REFERENCES

1. Rashid. M. H, "Power Electronics Handbook", Academic press, 2001.
2. Erickson. R., Angkrtitrakul. S, Al – Nasean. O and Lujan. G, "Novel power electronics systems for wind energy applications" – Final report, National Renewable Energy Laboratory, Colorado, US. – Aug 24, 1999 Nov 30, 2002.
3. Rai. G. D, "Non conventional energy sources", Khanna publishers, 4th Edition 2000.
4. B.H.Khan, "Non Conventional Energy Resources", Tata McGrawHill, 2nd Edition 2006.
5. J.K.Manwell, J.G.McGowan, A.L.Rogers, "Wind energy explained – Theory Design and applications", John Wiley& Sons, 2nd Edition 2009.

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CO2	3	3	3	2	2	1	-	-	-	-	3	-	3	3
CO3	3	3	3	2	2	1	-	-	-	-	3	-	3	3
CO4	3	3	3	2	2	1	-	-	-	-	3	-	3	3
CO5	3	3	3	2	2	1	-	-	-	-	3	-	3	3